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Electronic Mail and Organizational Knowledge: Media Use in a Global Corporation

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Abstract

Several attributes of communication media influence the costs of their use and utility, and these in turn have the potential to influence their patterns of use and organizational consequences. The goal of this paper is to examine some of these media attributes and their consequences in a large international firm. The data come from a survey of 973 employees of a multi-national corporation. They show that the distinguishing attributes of different media are not dominant: people whose jobs require substantial communication are likely to communicate heavily using all media available to them. The best predictor of which medium is used is the extent to which the medium can put people into contact with their important communication partners. When the job is the unit of analysis, the data from this survey do not support the media richness hypothesis — that use is determined by the fit between the richness of a medium and the degree to which people have complex, ambiguous, or social jobs. Yet when one takes a single conversation as a unit of analysis, the data show that media differing in interactivity and expressiveness are valuable for different tasks.

Employees who use electronic mail extensively are better informed about their company and more committed to its management's goals. One reason for their superior knowledge about the organization seems to be that electronic mail promotes "information spillover" from a focal recipient to others less directly interested in a message, without subjecting these marginal parties to the burdens of interruption and information overload.

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Media attributes and differential use

Over the last fifteen years the communications media available to employees of large organizations has proliferated. Facsimile (fax), electronic mail, and video-conferencing now routinely supplement long-standing media such as face-to-face meetings, postal mail, and the telephone. The traditional media themselves have been changed: many telephone systems now include voice mail, and postal mail includes faster overnight service.

This diversity of media presents a challenge both for communications theorists, who seek to understand this ecology of communication and the factors that determine the use of one medium rather than another, and for organizational theorists, who seek to understand the consequences of differential media use for organizational behavior and effectiveness. In this paper we try to address both concerns. First we draw upon existing theories to identify factors that predict frequency of use of various media, and we test the relative success of competing theories in explaining variance in use. Second, we examine organizational outcomes of use, in particular whether frequent use of one medium rather than another allows organizational members to be better informed about their organization. We then retrace our steps, using our findings regarding media impact to develop two concepts -- "information spillover" and "communication intrusion" -- which we posit as important attributes that distinguish media.

Although many researchers have noted that social and organizational factors play a large role in influencing patterns of media use and their organizational effects (e.g., Fulk, Schmidt, & Steinfield, 1990), most theories seeking to explain why and where one medium is used rather than another begin with attributes of the media themselves. The following theories differ on which attributes of various media are most salient for users, and which differentiate among alternate media.

Media richness & social presence: Both media richness theory and social presence theory distinguish between media according to their carrying capacity, the amount and kinds of information that can be carried by a medium. Daft and Lengle (1984 & 1986) argue that media differ from each other on richness: (a) the availability of instant feedback, (b) the capacity of the medium to transmit multiple cues, (c) the use of natural language, and (d) the personal focus of the medium¹. Media

¹ Other researchers have empirically decomposed the single dimension of richness into two dimensions -- interactivity and expressiveness (Fish, Kraut, Root, & Rice, 1993; Kraut, Galegher, Fish, & Chalfonte, 1992; Zmud & Young, 1990). Interactivity is high when communication partners

richness theory hypothesizes that individuals match the richness of the media they use with the tasks they need to perform. According to this theory as well as Short, Christie and William's (1976) related social presence theory, richer media can better support more ambiguous, complex, emotional, and social interaction.

Both the media richness and social presence theories lead to a congruency hypothesis that people whose jobs are more social, ambiguous, or complex would be expected use richer -- interactive and expressive -- media more.

Critical mass: Interactivity and expressiveness are hypothesized to have their effects because a good fit between these attributes and a task makes a medium more valuable. Other dimensions of media also influence their value. Critical mass models of media treat network externalities as the major determinant of both benefits and costs (Allen, 1988; Markus, 1987). In particular, the theory proposes that media become more valuable for their basic communication functions as more individuals and organizations are connected to them. Thus, for example, a fax machine becomes more valuable if one can be assured of getting a message through to customers, suppliers, or work colleagues, regardless of the medium's suitability for any particular message. At the extreme, the theory hypothesizes that in the case of potentially rival media, such as facsimile and electronic mail, one medium will drive out the other in a communications community, as users try to minimize the costs of having to encode a message in multiple media (Markus, 1987). In addition, not only does the spread of a medium make it more useful for communication, it often reduces both the personal costs (e.g., ease of learning) and the financial costs (e.g., price of capital equipment and costs per message) of use.

A medium's penetration (i.e., the percentage of the relevant communication community who uses it) in part results from factors extrinsic to the medium, including deployment policy or even historical accident. Thus, the telephone is available in over 91% of households in the United States and in virtually all business establishments because of an explicit policy for universal access promulgated by the telephone companies and regulating agencies. Media attributes also influence penetration. Face-to-face communication intrinsically has a local scope; one can only speak easily to those who are geographically close. Media also differ in their openness; media like the telephone and facsimile, which follow industry standards, would be expected to have greater penetration, value, and use than media like electronic mail or voice mail, where standards are more parochial. In these less-open technologies, messages often cannot be exchanged outside of one's company or even one's building.

This paper tests the hypothesis that people will use a communication medium more if the medium allows them to communicate with a larger proportion of their potential communication partners. Among other predictions, this implies that as their jobs require employees to communicate more often with geographically distant communication partners, they will rely less upon face-to-face communication and more upon all distance-mediating media -- from phones to electronic mail. The more they communicate with people who are not members of their own corporation, the less likely

can exchange information rapidly, adjusting their messages in response to signals of understanding or misunderstanding, questions or interruptions (Clark & Wilkes-Gibbs, 1986). Face-to-face communication and telephone conversations are obviously more interactive than fax and electronic mail. Expressiveness is high when a communications medium allows individuals to convey not only the content of their ideas through multiple media like figures and graphs as well as text, but also the intensity and subtleties of meaning through intonation, facial expression or gestures. Face-to-face communication and phone conversations are both equally interactive, but face-to-face communication is more expressive. Voice mail, facsimiles and electronic mail are all non-interactive. Because voice mail can encode tone of voice and inflection, and facsimiles can encode letterheads, pictures and the vagaries of handwriting, they are more expressive than electronic mail, which generally can send only text without even expressive variation in typography.

they will be to use technologies constrained by proprietary or company-specific standards (i.e., voice mail and electronic mail in this company) and more likely they will be to use media which have open standards (i.e., telephone, fax, and express mail services).

Disruption as a media attribute: There are other sources of benefit and cost for using a technology besides the number of communication partners available. Among the important properties of a medium is the extent to which it disrupts the user's work life. Communication is a resource-consuming process. It takes effort and attention to send or receive communication. One would therefore expect that the more people communicate, the more they will feel rushed and overloaded. However, some media are less intrusive than others. In particular, synchronous media, such as face-to-face meetings or telephone conversations, in which interaction takes place in real time, are likely to be far more disruptive than asynchronous communication, such as fax or electronic mail, where communication occurs through staggered rounds. When a phone call comes in, one has to stop what one is doing to answer it, while an electronic mail or facsimile message can be read and responded to on one's own schedule.

The disruption caused by a communication episode is likely to depend on a participant's communication role. Typically, one party initiates the communication and another is a recipient.² These participants typically have different goals and experience different benefits and costs in executing the communication. The initiators start the communication to accomplish some instrumental or social end. They place a phone call, have meetings, or initiate visits to get work done, to renew social bonds, or simply to pass time. Because they initiate the communication attempt, they can often fit it conveniently into their schedule. For example, they place telephone calls when it best suits them. On the other hand, the recipient of a communication attempt can frequently be thought of as an object of the initiator's designs. In many cases, especially in business settings, the recipient is intended to be a source of information or aid. Moreover, from the recipient's perspective, the communication attempt is likely to arrive at a random time, often interrupting on-going and more important activity.

Thus initiators and recipients of communication are likely to experience the same communication very differently. Despite these differences, most analyses of media choice and media effects have not explicitly treated the sender/receiver roles of communication participants.

The magnitude of these role differences in the perceived value and costs of communication is likely to depend on medium. In particular, we will test the hypothesis that role differences will be reduced in asynchronous media, such as electronic mail, fax, or voice mail, which allow recipients to schedule their receipt of messages.

Media substitution or synergy? The common-sense view is that different communications media are competitors or potential substitutes and that communication as a zero-sum game. For example, if one chooses to fax a piece of information, one need not mail the same document. Similarly, one uses a telephone call instead of an electronic mail message. And to the extent there is congruence between the demands of certain jobs and the relative advantages of different media, one would hypothesize that people will specialize in the use of certain media, or at least have lopsided use patterns. Thus one might expect that people who send a lot of electronic mail send fewer faxes, or that heavy use of phone calls implies lower frequency of face-to-face communication. Across a

² Kraut, Fish, Root & Chalfonte (1991) documented that in some settings roughly half of face-to-face conversations are not intentional, in the sense that neither party planned to have the conversation even moments before it occurred. Rather, many of these conversations happened simply because people were at the same place at the same time. The distinction between initiators and recipients breaks down in these spontaneous conversations. In addition, the distinction becomes blurry when one party is returning another's unconsummated communication attempt. Finally, once in a conversation, the speaking turns may shift, and goals and outcomes may shift as well. Thus, the initiator/recipient distinction is not a rigid one, but we believe it provides a useful lens for viewing the costs and utility of communication.

sample of individuals, this would imply negative correlations between measures of use for different media: heavy users of medium A would tend to be low users of media B, and vice versa.

An alternative perspective views the existence of multiple media as additive or synergistic, rather than substitutional. Thus someone sends a fax prior to phoning about a matter. Or someone might send electronic mail to follow up a face-to-face meeting. This second view implies that heavy use of one medium would lead to heavy use of others. Aggregated across a sample of individuals, it hypothesizes positive correlations between measures of use for different media.

These two alternative hypotheses concerning media use are tested below.

Communication Media and Organizational Peripherality

Spontaneous conversation and observation are two mechanisms through which organizational culture and knowledge are transmitted. Typically, in large organizations members learn much of their technical knowledge and a substantial amount of incidental information by bumping into interesting people or situations (Kusterer, 1978; Lave & Wenger, 1991). Both informal communication and observation are enabled by organizational members' physical proximity (Allen, 1977; Conrath, 1973; Monge, Rothman, Eisenber, Miller, & Kirste, 1985). Employees use unplanned encounters both to keep up with information about customers, technical developments, or company politics and to learn the often unwritten rules of performance, such as the degree to which customer service is valued or the extent fudging is tolerated in expense vouchers. Members who are at the periphery of an organization have fewer opportunities for spontaneous conversation with colleagues, and fewer opportunities to observe others working or in interaction with each other. Peripheral organizational members are thus disadvantaged in knowing about their work environment. The disadvantages of organizational members at the periphery have been documented numerous times (e.g., Festinger, Schacter & Back, 1950; Hesses, Sproull, Kiesler, & Walsh, In press). This paper will examine the peripherality effect and the roles that different communication media play in affecting peripherality.

Organizational peripherality is partially a geographic phenomenon. Zipf (1949), Festinger et al (1950) and Allen (1977) all documented how rapidly communication declines with distance. For example, in research and development environments, the probability of interaction between any two individuals drops to its asymptote within 30 meters (Allen, 1977). Even people who are actively collaborating on a project are much less likely to communicate as their offices are further apart or are separated by physical barriers like doors, stairwells, or building boundaries (Kraut, Fish, Root, & Chalfonte, 1990). In national or international corporations, with very large distances between sites, the difficulties of spontaneous contact are compounded by time-zone differences and transportation difficulties that make even intentional contact and attendance at common meetings difficult.

While being peripheral in an organization is partially a matter of geography, it has other dimensions as well. Seniority, occupational prestige, and placement in informal social networks affect peripherality and may have influences both on communication and on organizational knowledge.

One would expect that with modern telecommunications, the disadvantages experienced by organizational members at the periphery should be reduced. In particular, face-to-face interaction is local, while the ability to communicate and even to have spontaneous exchanges using electronic media is less hampered by distance. Feldman (1987), Hesse, Sproull, Kiesler & Walsh (1993), and Huff et al (1989) all argue that electronic mail is especially well suited to reduce the peripherality disadvantage. First, electronic mail has features like distribution lists and electronic bulletin boards to increase the number of people who will receive any particular communication. This mechanism allows people to bump into information and other organizational members serendipitously. Second, Kiesler and Sproull (1986), among others, argue that compared to other media, electronic mail reduces social context cues, so that the content of a message tends to be disassociated from its source; this feature should reduce some of the peripherality deficits associated with low status, gender, and other personal attributes. Thus, one might expect that heavy use of electronic media, especially electronic mail, might compensate for geographic peripherality.

Yet other data suggest that these distance-reducing technologies are often used to bolster prior face-to-face communication. Using these electronic media, people communicate most with the same people they talk to face-to-face (Rice, 1992). In addition, even though the technologies are relatively insensitive to distance³, people communicate most with those who are geographically close to themselves (see Eveland & Bikson, 1987 for the case of electronic mail and Mayer, 1977 for the case of the telephone). The implication of these latter findings is that electronic media may *not* reduce the differences between centrally located and peripherally located individuals, but may indeed exacerbate pre-existing inequalities in communication and knowledge within an organization.

A major purpose of this paper is to examine the extent to which differential use of various media is indeed associated with improvement in organizational knowledge. That is the goals are to determine the extent to which differential use of media reduces the peripherality deficit and to identify some of the characteristics of the media that might be associated with these influences on organizational knowledge.

Methods

We conducted a survey of high and low electronic mail users in the US and international locations of a large corporation in 1992. We selected this organization for study, because it was a multinational firm, which made problems of peripherality likely, with one of the oldest and largest electronic mail networks in the world. At time of the study, this corporation had about 85,000 employees in over 83 countries on six continents. Its electronic mail network was almost ten years old and had over 26,000 users spread across North America, Europe, Latin America, and Asia. The corporation invested approximately 14 million dollars per year in running and maintaining its electronic mail network.

The electronic mail package that most employees used allowed them to send to and receive messages from other users of the company-sponsored network, but did not support gateways to external networks.⁴ The electronic mail package consisted of a corporation wide directory, commands for sending messages to individuals and locally created mailing lists, and a rudimentary news and clipping service. The system also had commands for looking up names, titles, and locations of individuals on the system, for saving messages to external files, and for up-loading formatted documents previously written on personal computers. Only system administrators were allowed to send broadcast messages to corporation-wide distribution lists, either to send corporate bulletins or as agents for senior executives. The user interface to the electronic mail system consisted of typed commands and a cumbersome line-oriented editor for composing and modifying messages. Users accessed the system by dialing in to a corporate telephone network.

Sample: Using lists provided by the corporation, we drew a sample of 2733 employees. Of these, 928 were a control sample of employees in the United States selected from the corporate phone book independently of whether they used electronic mail. The remainder was a stratified random sample of employees who had used an electronic mail account in 1991. Stratification was used to insure variation in respondents' geographic location relative to corporate headquarters and also the frequency of their use of electronic mail. Of the stratified sample, 1097 individuals were located at corporate headquarters, 261 were located in other parts of the US, 254 were located in London, and 261 were located in Hong Kong. Among these employees approximately half were selected to be at approximately the 25th percentile and half at the 75th percentile of frequency of electronic mail usage (i.e., we sampled heavy and light users, but not the far extremes).

³ Costs for phone and fax communication rise with distance, but this slope has decreased in recent years.

⁴ That is, users could send messages to others who weren't company employees only if these individuals had been given a corporate account.

Of the questionnaires sent out, 403 were returned as undeliverable. After sending a reminder postcard and a follow-up questionnaire, we received 973 completed questionnaires, which is an effective response rate of 42% [973/(2733-403)].

Questionnaire and analyses: In order to examine media use we constructed a multipage questionnaire that probed employees' organizational knowledge, job attributes, media use, and demographic control variables. Appendix 1 provides the wording and reliabilities for most measures of relevance to this paper; most Chronbach alpha measures for multi-item scales were between .60 and .80, showing lower reliability than we would have liked, but sufficient for exploratory research with a large sample. The demographic variables included age (which was highly correlated with job seniority) and gender.

The job attributes were ones expected to be related to communication intensity or that previous researchers had demonstrated to be associated with media choice. They included *organizational level* (from staff member to vice president) and such material conditions of work as *working outside normal location or hours* and *having a secretary*. From Van der Ven et al (1976), we derived measures of *procedural work* (the degree to which a job consisted of routine tasks) and *work interdependence* (the extent to which a job required coordination among multiple parties). From Cammann et al (1983) we derived measures of *work overload* (the degree to which an employee had too much to handle and was frequently interrupted) and *work challenge* (the degree to which a job tapped a variety of skills). From Bikson (1986) and Bikson and Markus (unpublished) we derived measures to characterize work tasks in more detail: *managerial work* (the extent to which respondents managed people or handled emotional situations), *sales work* (the extent to which a job required sales or persuasion), *text work* (the extent to which respondents read and wrote), and *quantitative work* (the extent to which respondents worked with numbers and charts).

We also tried to characterize the social component of jobs in more detail: *working on task forces* (the extent to which employees worked with temporary groups) and *working with outsiders* (the extent to which employees worked with people who were organizationally or geographically remote).

As outcome measures we were interested in respondents' organizational knowledge and their organizational commitment. The *organizational knowledge* scale consists of an eight-item multiple choice test of facts about the company that had been published in national newspaper articles in the six months prior to the distribution of the survey. The *organizational commitment* scale came from a survey that the company had conducted 12 months prior to our research, as part of its regular assessment of corporate morale. The latter focused on respondents' evaluation and agreement with senior management's strategic direction.

Our primary measure of *peripherality* was geographic, the distance between an employee's work location and corporate headquarters, coded in three steps (at corporate headquarters, in other areas of the United States, or abroad). Demographic and job characteristics such as age, gender, and managerial level provided supplemental measures of organizational peripherality.

The questionnaire probed each user's experience with several communication media, focusing on electronic mail and fax, but also including questions about face-to-face communication, telephone conversations, voice mail, and overnight mail services. The questions included both aggregate and episode-specific items. In the aggregate items, respondents averaged their descriptions or estimates over many experiences. They estimated the number of conversations or meetings they had per day and the electronic mail, voice mail, facsimile, overnight mail and telephone calls they sent and received during a typical week. Since these distributions had a long tail, they were converted to the log scale in the analyses that follow. To derive a measure of total communication, we converted these estimates to a common base and summed them. Respondents also estimated what percentage of the people with whom they need to communicate with work could be reached through each medium.

The episode-specific questions asked respondents about the most recent communication episode they had in each of four communication modalities: face-to-face, telephone, fax, and electronic mail. They indicated who initiated the episode, whether they kept a written record or notes about the

communication; the extent on 3-point Likert scales to which the communication interrupted work, and the usefulness of the communication along three dimensions derived from McGrath (1984): a) getting work done, b) developing or sustaining a work relationship, and c) keeping up with organizational news, politics, or people. Even though each respondent described multiple communication events (one for each modality), in the analyses that follow we randomly selected one event for each respondent to control for the inflation in degrees of freedom⁵. Analyses using the episode-specific questions treated the media as differing on two dimensions: interactivity and expressiveness. Interactivity contrasts face-to-face and phone communication with fax and electronic mail communication. We examined expressiveness within interactivity, through two single degree of freedom contrasts. One contrasted face-to-face communication with phone communication and the second contrasted fax communication with electronic mail.

Results

Media use

Total communication. Respondents reported having a large amount of communication. Over all media, respondents reported having an median of 265 conversations or messages per week (interquartile range was from 172 to 394) or more than 1 communication every 11 minutes in what they report to be a 9.7 hour work day⁶. They estimated they spent 3.8 hours per day communicating, or 39% of their time. While diary studies (reviewed by Panko, 1992) argue such estimates are only moderately accurate, they typically underestimate the total amount of communication, since respondents frequently discount brief or routine communication episodes.

We found that at the aggregate level, different media are additive or synergistic rather than zero-sum substitutes. People who communicate heavily in one modality tend to communicate heavily in others as well. Table 1 shows the intercorrelations among the measures of media use in the log scale. While the average correlation is weak, (mean $r = .16$) all are positive, and summing the amount of communication across the six modalities produces a communication intensity scale with a Chronbach's alpha of .51. Because communication across media is intercorrelated, when testing for associations of electronic mail in the analyses that follow, we hold constant the use of other media by constructing a scale consisting of the sum of all other communication media.

	Electronic mail	Facsimile	Voice mail	Overnight mail	Phone calls
Facsimile	.177	1.000			
Voice mail	.006	.164	1.000		
Overnight mail	.120	.488	.103	1.000	
Phone calls	.195	.340	.218	.211	1.000
Face-to-face	.064	.067	.037	.113	.079

Table 1: Correlations among use (in log units) of different communication media

Note: Ns range from 757 to 94. Correlations greater than .064 are significant at least the .05 level.

Total communication volume is partially explainable by rational need to communicate based on job function: We used job and personal characteristics to predict the amount (in log units) individuals would communicate. People who worked alone communicated less, while those whose jobs involved selling, working on task forces, working outside the conventional business schedule and

⁵ We conducted the episode-specific analyses multiple times, using different random samplings of events for individuals. All of the episode-specific results we report below replicate across samples.

⁶ Respondents reported that on a typical work day they worked about an hour and three quarters outside of normal business hours, in addition to their conventional work day.

location (and therefore having greater coordination needs), and those who had more challenging work report higher rates of communication across modalities. (See Column 1 in Table 2.)

Variable	Total communi- cation	Elec- tronic mail	Fax	Voice mail	Overnight mail	Face- to-face	Phone
Intercept	.03	.00	.00	.00	.00	.00	.00
Use of other communication media	a	.21	.29	.23	.17	.20	.43
Communication penetration	a	.33	-.12	.60	a	.21	a
Gender (Male)			-.11				
Management level		.07	.15	.03	.06	-.02	-.02
Have a secretary			.08	-.10			
Number supervised				-.06			
Do managerial work		.16	-.09				
Do sales/persuasion work	.16				.12		.09
Do quantitative/graphics work		-.17	.09				
Work alone	-.21	-.08				-.11	
Work with customers & distant others		.08	.27		.15	-.11	.09
Work outside normal hours & location	.14	.13		.08	.09		
Work in task forces	.08			.07			
Work is challenging	.12					.11	.07
Work is procedural		-.07					
Geographic peripherality		.23		-.19			
Adjusted R squared	.16	.30	.25	.58	.14	.10	.25

Table 2: Predicting the overall communication volume and the use of individual media.

Note: Entries are standardized beta weights which are statistically significant at least the .05 level.

^a Independent variable was not measured or included in the analysis as relevant

Differential use of media: Our analyses show that the critical mass model does a better job than the media richness and social presence models of explaining use of particular media, holding constant overall communication volume. The analyses in this section treat the frequency of use of each medium as a dependent variable, and then treat the total amount of communication in other media, respondents' estimates of the percentage of their communication partners who can be reached by the medium (communication penetration), and job and personal characteristics as independent variables in an ordinary least squares regression. Independent variables that were not significantly related to communication were dropped from the analysis, and the regressions were rerun to determine the coefficients. Table 2 reports standardized coefficients or beta weights which are statistically significant at the .05 level or better.

The critical mass variables were consistent predictors of media use⁷. People use a medium more if it allows them to communicate with a larger proportion of their communications partners⁸.

⁷ The questionnaire did not ask respondents what proportion of the communication partners were available by phone or express mail, since pretesting showed that all communication partners were available by these media.

⁸ The penetration question for face-to-face communication, electronic mail, and fax asked respondents to estimate the proportion of the people they needed to communicate with who were

However, there is variation in the importance of critical mass across the media. Penetration was a very strong predictor of the use of voice mail, moderately strong for communicating face-to-face or by electronic mail, and negatively associated with the use of fax.

We had expected that people whose jobs required them to communicate with others outside the company would be more likely to use open and standardized communication modalities. The evidence is partially consistent with this hypothesis: the association of working with outsiders and using a medium was reliably stronger for two open technologies -- fax and express mail -- than for two proprietary and local media -- electronic mail and face to face communication. However, the association with telephone use, an open medium, and with electronic mail, a closed medium, were about the same; perhaps this reflects time differences that make the telephone less useful for communication across time zones.

Media richness theory led to predictions that as employees performed more social, managerial, or uncertain work, they would be more likely to use rich media. Table 2 provides only weak support for this hypothesis. Thus, people who do managerial work (managing people, handling emotional situations and scheduling) use electronic mail -- a lean medium -- more and fax -- a richer medium -- less. There is no relationship between managerial work and the use of the richest media (face-to-face communication and phones). Similarly, people whose work involves sales and persuasion were more likely to use the phone (a rich medium), but also more likely to use express mail (a lean medium). People who had the most procedural (i.e., least uncertain) tasks are less likely to use electronic mail, a lean medium.

Finally, we had expected that people who were peripheral to their organization in a number of ways would be especially apt to use electronic mail, because of its potential ability to remedy the problems associated with their geographic and organizational isolation. The data are consistent in showing that employees who were geographically distant from corporate headquarters were more likely to use electronic mail. Unexpectedly, however, we did not find that women or lower level employees were more likely to use electronic mail than males or higher level employees. Indeed, higher managerial level was associated with greater use of electronic mail.

Work outcomes

Our basic hypothesis about the consequences of media use was that people who were peripheral to an organization would be disadvantaged in keeping up with relevant organizational information and would feel less committed to the organization. Because electronic mail has attributes that could help to overcome these deficits, heavy users of electronic mail would be more informed and committed.

Tables 3 through 5 show regressions predicting scores on the organizational knowledge scale, the organizational commitment scale, and the overload scale; independent variables in both analyses include demographic and job attributes that predicted electronic mail usage as well as variables that preliminary analyses showed were related to each dependent variable. For each dependent variable, we conducted three analyses: 1) a basic analysis in which the predictors are geographic peripherality and the control variables, 2) an analysis that added electronic mail use, and 3) an analysis that added the electronic mail by peripherality interactions. The tables show standardized beta coefficients for variables significant at at least the .05 level.

Organizational knowledge. The data are consistent with the hypothesis that peripheral employees are less informed about their company and that heavy electronic mail users are more informed, over and above their use of other communication media. Table 3 shows, first, that peripheral people are indeed less knowledgeable about their company. Thus, women know less than men, those at lower managerial levels know less than those at higher managerial levels, and those

accessible by these media, while the voice mail measure asked what proportion had voice mail or answering machines.

who work in Asia, European, or other sites in the United States know less than those located at corporate headquarters. Second, the results show that people who use electronic mail more know more about the organization, while extensive use of other communication media was not associated with organizational knowledge. Finally, we tested the prediction that the use of electronic mail would alleviate the deficits in knowledge associated with geographic and other peripherality (i.e., the peripherality X electronic mail interaction); the last column in Table 3 shows the interaction between electronic mail use and geographic peripherality. None of electronic mail X peripherality interactions (i.e., geographic, gender, age, or managerial level) approached significance.

Variable	Control variables	Control + Email	Control + Email + Interactions
Gender (Male)	.15	.15	.15
Management level	.20	.19	.19
Have a secretary	.10	NS	.10
Do managerial work	-.08	-.09	-.09
Do quantitative/graphics work	.08	.10	.10
Work alone	NS	NS	NS
Work with customers & distant others	.08	.08	.08
Work outside normal hours & location	NS	NS	-.04
Work is procedural	NS	NS	NS
Geographic peripherality	-.15	-.17	-.16
Use of other communication media	NS	NS	NS
Use of electronic mail		.14	.13
Electronic mail X peripherality			NS
Adjusted R squared	.137	.150	.150

Table 3: Predicting organizational knowledge from electronic mail use and control variables.

Note: Entries are standardized beta weights significant at least the .05 level.

N = 683

Organizational commitment. Geographic and other peripherality did not predict organizational commitment. Rather, people who had routine work and those with the challenging jobs were more committed to senior management plans, while those who worked alone were less committed. People who used electronic mail more reported more commitment in the direction of the company and their leaders' decisions, while those who had heavy communication volume through other media were less committed. Again, none of the peripherality X electronic mail use interactions approached significance. (See Table 4).

Variable	Control variables	Control + Email	Control + Email + Interactions
Management level	NS	NS	NS
Do managerial work	NS	NS	NS
Have a secretary	.08	NS	NS
Do text/analysis work	NS	-.08	-.07
Do quantitative/graphics work	NS	NS	NS
Work alone	-.10	-.09	-.09
Work with customers & distant others	NS	NS	NS
Work outside normal hours & location	NS	NS	-NS
Work is procedural	.20	.21	.21
Work is challenging	.14	.14	.14
Geographic peripherality	NS	NS	NS
Use of other communication media	NS	-.08	-.08
Use of electronic mail		.10	.10
Electronic mail X peripherality			-.01
Adjusted R squared	.072	.078	.078

Table 4: Predicting organizational commitment from electronic mail use and control variables.

Note : Entries are standardized beta weights significant at least the .05 level.
N = 748.

Communication spillover. One mechanism through which heavy use of electronic mail could enhance organizational knowledge is what we term a communication spillover effect. In using electronic mail, the ease of adding additional readers and electronically copying documents means that news and information addressed to one person is often routed to others who are marginal to the original conversation and who had expressed no direct interest in being party to it. Routine audits of the electronic mail traffic at this corporation showed that a typical message has 3 or 4 recipients. Examining the ratio of messages received to messages sent in our sample suggests that they received more information by electronic mail than they gave off. People received 2.7 incoming electronic mail messages for every outgoing one. For other media, the ratio of received to sent is closer to 1:1. (For fax the received to sent ratio is 1.2 and for telephone calls it is 1.1.) This distinctive characteristic of electronic mail⁹ means that through electronic mail people can 'bump' into information that they had not intended to see, much as physical proximity serendipitously puts them into contact with other people.

The use of electronic bulletin boards or clipping services might be a more direct mechanism for electronic communication to lead to organizational knowledge. While typically people who use electronic mail are also likely to subscribe to corporate electronic bulletin board services, in this corporation these services were used infrequently. Within the 6 months prior to the survey, only 26% of the sample had used them at all, and these respondents used the services less than once per month. Thus, the use of bulletin board services is unlikely to account for the association of electronic mail use with organizational knowledge.

⁹ In principle, voice mail could be used the same way, but interviews and survey data in this organization suggests that voice mail is used primarily for its answering machine functions.

Overload & interruptions. Even though electronic mail brings people into contact with 'surplus' information and thus increases the total amount of communication and information they receive, it does not increase their psychological experience of being overloaded, rushed, or interrupted. Table 5 shows the regressions predicting the overload scale from electronic mail use and the control variables. People who communicated more across all media reported experiencing more overload. However, increases in electronic mail use were not associated with more overload, once other communication was statistically controlled.

Variable	Control variables	Control + Email	Control + Email + Interactions
Management level	NS	NS	NS
Do managerial work	.14	.14	.14
Do text/analysis work	.17	.16	.16
Do quantitative/graphics work	NS	NS	NS
Work alone	NS	NS	NS
Work with customers & distant others	NS	NS	NS
Work outside normal hours & location	NS	NS	NS
Work with task forces	NS	NS	NS
Work is procedural	-.07	-.07	-.07
Work is challenging	.16	.16	.16
Geographic peripherality	NS	NS	NS
Use of other communication media	.16	.16	.16
Use of electronic mail		NS	NS
Electronic mail X peripherality			NS

Adjusted R squared

Table 5: Predicting overload from electronic mail use and control variables.

Note: Entries are standardized beta weights significant at least the .05 level.
N = 759.

The episode-specific analyses also show that electronic mail, by virtual of being an asynchronous medium, provides information without being intrusive. Figure 1 plots responses to the question, "How much did this communication interrupt your work?" by media and communication role (initiators or recipient). A communicator role X interactivity X expressiveness analysis of variance shows that synchronous media are substantially more intrusive than asynchronous media ($F(1, 824) = 83.8; p < .001$), and that recipients of communication are interrupted more than initiators ($F(1, 824) = 6.62; p < .01$). The significant interactivity X role interaction shows that the difference between recipients and initiators occurred only for the two synchronous media. Among the synchronous media, telephone and face-to-face communication were not reliably different.

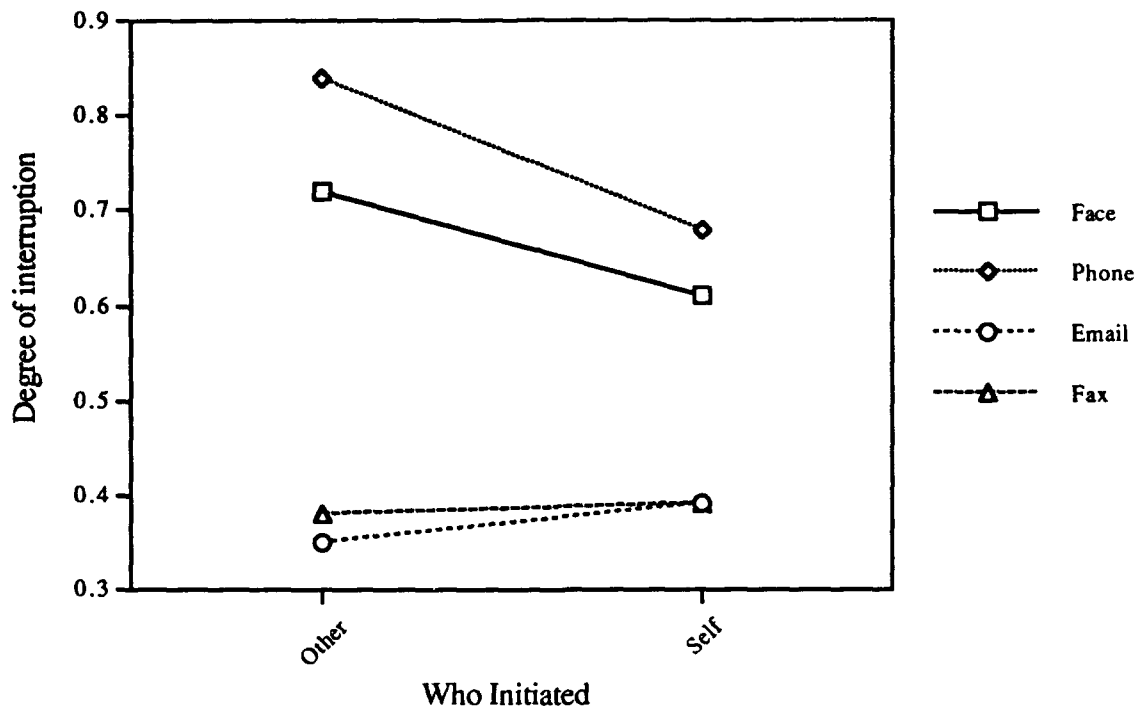


Figure 1: How much did a communication episode interrupt work, by modality and communication role.

Communications value. Not only were people more likely to receive messages by electronic mail than send them, but our evidence shows that compared to other media, the messages were perceived to be especially valuable for keeping up with organizational information (as opposed to getting focal tasks done or maintaining personal relationships). Respondents evaluated a recent communication episode on three dimensions: getting work done, maintaining a work relationship, and keeping up with corporate information. Table 6 presents the means and standard errors of these estimates for respondents who reported initiating a communications episode and for those who reported being the recipient of one.

How useful was the communication for:	Face-to-face	Phone	Electronic mail	Fax
Getting work done	1.24 (.48)	1.28 (.56)	1.54 (.68)	1.34 (.58)
Developing or sustaining a work relationship	1.26 (.53)	1.36 (.60)	1.75 (.77)	1.74 (.77)
Keeping up with corporate news, politics, or people	1.99 (.76)	2.08 (.86)	1.95 (.85)	2.46 (.76)

Table 6: Judged usefulness of communication episode for work functions

Note: Entries are means (and standard deviations) on a 3-point scale, where 1 = Very useful and 3 = Not at all useful. Ns range from 766 to 92.

Analysis of variance shows that for the work and relationship dependent measures, initiators perceived the communications to be more valuable than did recipients, and for all three dependent variables that synchronous communication was perceived as more valuable than asynchronous media. However, electronic mail was judged to be especially useful for keeping up with company news, personalities and gossip. For this purpose, electronic mail was rated as positively as face-to-face communication and significantly better than fax ($F(1,810) = 7.35, p < .01$).

Recording communication. Finally, the communication episode data show that people were more likely to keep records of communication they had over asynchronous media (about 63% of messages) than over synchronous media (about 38% of conversations), presumably because electronic mail and fax were already in a recorded form ($F(1,813) = 29.7, p < .001$). Although respondents reported to be slightly more likely to keep records of fax communication (70%) than of electronic mail (64%), this difference was not reliable ($F(1,813) = .13; p > .50$).

Discussion

In summary, this research has illustrated some mechanisms through which attributes of different communication media might influence their benefits and costs and, as a consequence, their organizational impact. In one sense, all media are equivalent or even synergistic, in that people whose jobs require substantial communication -- those who work with others, who work on temporary teams, or whose work involves sales or persuasion -- communicate more across all of the media available to them. The best predictor of the extent to which they use a particular medium is their estimate of the ability of that medium to put them into contact with their important communication partners.

Surprising, the fit between the richness of particular media and the degree to which employees have complex, ambiguous, or social jobs does not explain patterns of use well. Thus, we found no evidence that people performing routine work were more likely to use lean media, and we saw that while people who perform socially oriented work like persuasion were more likely to use an interactive medium, like the telephone, they are also likely to use non-interactive media, like overnight mail. The failure to find consistent support for the media richness hypothesis may have a methodological explanation. That is, it is possible that different media are especially suited for different tasks, but that the typical white collar job in this corporation may be too varied in the tasks that compose it for strong relationships between job attributes and media use to emerge. Our data show that when a single conversation is the unit of analysis, media differing in richness are valuable for different tasks.

The data also show 'richness' itself may not be a useful concept. Rather its underlying dimensions -- interactivity and expressiveness -- may provide the explanatory power, since these dimensions have different associations with tasks. Compared to communication occurring over asynchronous media (fax and electronic mail), synchronous communication (i.e., face-to-face conversations and telephone calls) were much more valuable for maintaining work relationships, moderately more valuable for doing work, and slightly more valuable for keeping up with organizational information. Among the synchronous media, the more expressive medium -- face-to-face communication -- was better than the telephone for relationship maintenance. Among the asynchronous media, the more expressive medium -- fax -- was better than electronic mail for getting work done.

Interestingly, communication by electronic mail was better than communication by fax for keeping up with corporate news, policy, and personalities. Moreover, employees who used electronic mail extensively, net of their use of other communication media, were better informed about their company and more committed to its management's goals. One reason for their superior organizational knowledge may be that electronic mail promotes information spillover from a recipient to others not directly interested in a message. This spillover phenomenon has been dramatically illustrated in several recent episodes in large corporations in which privileged information spread throughout the corporation via electronic mail. Electronic mail compared to other media requires little effort to add multiple recipients to a message, to send messages to distribution lists, or to capture electronic messages for resending. Because it is an asynchronous medium, electronic mail allows marginal parties to receive spillover information without the burdens of interruption and information overload and to keep records of the information they receive.

We cannot conclusively document the causal effects of electronic mail on organizational knowledge through the present cross-sectional survey. But if the reasoning we have just presented is correct, it suggests that secondary properties of communication media (beyond their penetration and richness) can have important organizational effects. In particular, the ease of creating and archiving

copies, of adding others to a mailing, or of scheduling communication make different media useful for different group functions. In the new media like the old, effort has surprisingly powerful organizational effects (Zipf, 1949).

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Appendix: Scale reliabilities and item wording

Text work (alpha = .71)

- a. Writing reports/documents
- b. Reading reports/documents
- c. Searching for or gathering information
- d. Assembling and distributing documents

Quantitative work (alpha = .65)

- a. Working with charts, graphs, or special displays
- b. Working with numbers

Sales work (alpha = .83)

- a. Bargaining, negotiating
- b. Persuading, selling

Managerial work (alpha = .60)

- a. Managing people
- b. Handling difficult emotional situations
- c. Scheduling

Work interdependence (alpha = .63)

- a. Working alone (reversed)
- b. I have a one-person job. To get work done, I can *independently* accomplish my tasks.
(reversed)
- c. To get my job done, I must work closely with others.

Work with outsiders (alpha = .60)

- a. Working with customers
- b. Working with people outside of the corporation
- c. Working with people in other cities in this country
- d. Working with people in other countries

Work in temporary teams (alpha = .59)

- a. Working individually with other people who change from week to week
- b. Working in temporary groups or task forces where membership changes regularly

Work outside normal hours & location (alpha = .75)

- a. Working at least part of the day at home during normal office hours
- b. Working at least part of the day at home outside of normal office hours
- c. Traveling out of the office
- d. Working outside of normal business hours

Procedural work (alpha = .71)

- a. To what extent is there a clearly defined body of knowledge or subject matter which can guide you in doing your work?
- b. To what extent is there a clearly known way to do the major types of work you normally encounter?
- c. To what extent do people in your work group do about the same job in the same way most of the time?
- d. To do your work, to what extent do you rely on established procedures and practices?

Challenging work (alpha = .65)

- a. To what extent does it take a long time to learn the skills necessary to do your job well?
- b. My job involves learning new skills or information on an ongoing basis.
- c. How much variety do you normally encounter in your tasks during a normal working day?
- d. How challenging is your job?
- e. On my job, I seldom get a chance to use my special skills and abilities. (reversed)

Penetration

- a. Of the people you need to communicate with to get your work done, what percentage are accessible to you by electronic mail?
- b. Of the people you need to communicate with to get your work done, what percentage are accessible by fax?
- c. Of the people you need to communicate with to get your work done, what percentage have voice mail or an answering machine?
- d. Of the people you need to communicate with to get your work done, what percentage are accessible to you for face-to-face conversation?

Total communication use (alpha = .51)

sum (electronic mail messages sent and received per week, faxes sent and received per week, voice mail or answering machine messages left or received per week, overnight mail pieces sent or received per week, phone calls placed or received per week, face-to-face conversations or meetings per day * 5).

Organizational knowledge (alpha = .76)

- a. At the end of 1991, approximately what percent of the corporation's consumer loans were not performing?
- b. To whom did the corporation contract to sell its share in Banco, its Italian subsidiary?
- c. The corporation announced plans to sell what asset?
- d. What initiative did the corporation recently announce?
- e. With whom is the corporation collaborating on a home banking system?
- f. What size was the corporation's 1991 loss?
- g. Whom did the corporation recently name as a vice chairman?
- h. What was the amount of the corporation's latest preferred stock offering?
- i. How many employees is the corporation expecting to cut in 1991 and 1992?

Organizational commitment (alpha = .80)

- a. I have a clear understanding of the corporation's strategic direction and goals
- b. I agree with the corporation's strategic direction and goals
- c. I have confidence that Senior Management will provide the leadership necessary to strengthen our businesses over the next two years
- d. How satisfied are you with the information you receive from Senior Management on what's going on in the corporation?

Overload (alpha = .76)

- a. In my work I am frequently jumping from one task to another.
- b. I frequently receive more information during the day than I can use.
- c. I never seem to have enough time to get everything done on my job.
- d. My work is frequently interrupted.
- e. I feel I have more to do than I can comfortably handle

Communication value

- a. Who initiated this communication?
- b. Did you keep a record of or notes about the communication?
- c. How useful was this communication for getting your work done?
- d. How useful was this communication for developing or sustaining a work relationship?
- e. How useful was this communication for keeping up with corporate news, politics, or people?
- f. How much did this communication interrupt your work?